



US Army Corps
of Engineers

Risk Management for Dam Safety

Planning CoP Conference

San Antonio, TX
19-22 May 2008

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Dam Safety Defined (Part 1)

“Dam safety is the art and science of ensuring the integrity and viability of dams such that they **do not present unacceptable risks to the public, property, and the environment.**”

Federal Guidelines for Dam Safety, Glossary of
Terms (FEMA 148), April 2004



Traditional Assessments

- Focus on guidelines
 - Positive net benefits
 - Pass inflow design flood (PMF for high hazard)
 - Withstand maximum design earthquake (MCE for high hazard)
 - Meet minimum factor of safety
 - Routine surveillance and periodic inspections



Risk Informed Assessments

- Focus on concept of tolerable risk
 - “Risk within a range that society can live with so as to **secure certain net benefits**.
 - It is a range that we **do not regard as negligible** or as something we might ignore,
 - but rather as something we **need to keep under review**
 - and **reduce it still further if and as we can.**”

Risk Assessment in Dam Safety Management: A Reconnaissance of Benefits, Methods and Current Applications (ICOLD 130), 2005

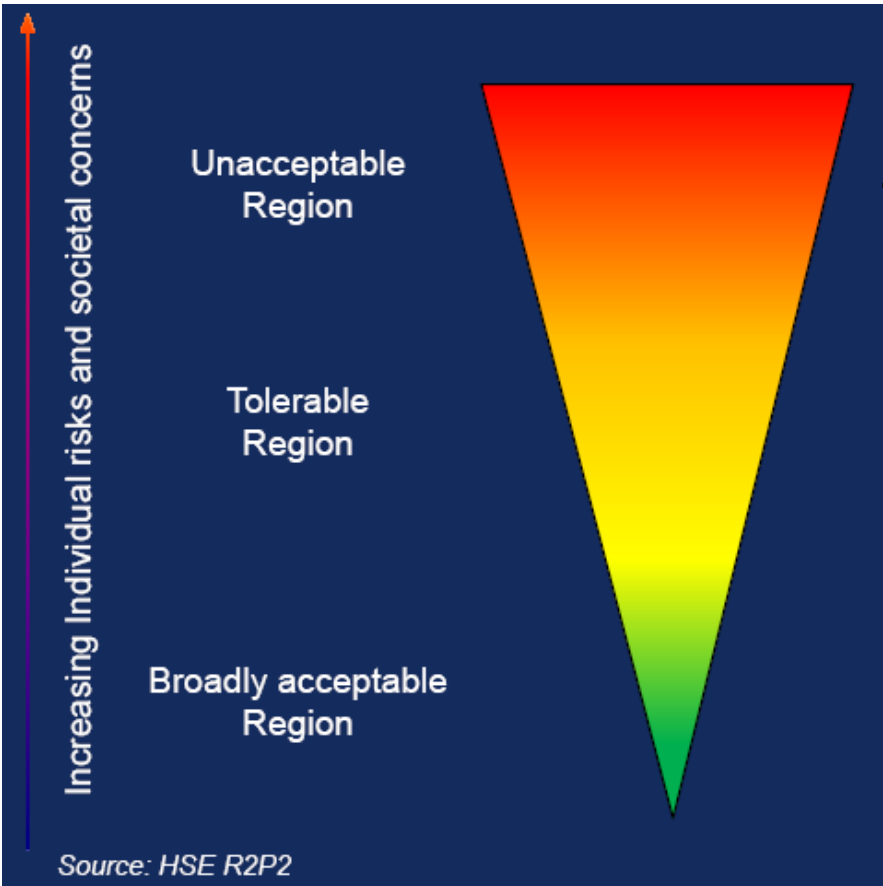


Tolerable Risk Principles

- Equity – The right of all individuals to equal and fair treatment in terms of a minimum level of safety
- Efficiency – The need for society to use available resources to realize the greatest benefit
- As Low as Reasonably Practicable (ALARP)
 - Existing good practice
 - Cost effectiveness – Cost per statistical life saved (CSSL)
 - Willingness to pay – Value in preventing a fatality (VPL)
 - Gross disproportion
 - Societal concerns



Tolerable Risk



→ Risk cannot be justified except in extreme circumstances

→ Risk tolerated in order to secure benefits. Residual risk subject to ALARP.

→ Risk regarded as insignificant and adequately controlled. Residual risk still subject to ALARP.



Dam Safety Defined (Part 2)

“It requires the collective application of engineering principles and experience, and a philosophy of risk management that recognizes that a dam is a structure whose safe function is not explicitly determined by its original design and construction”

Federal Guidelines for Dam Safety, Glossary of
Terms (FEMA 148), April 2004



Traditional Management

- Emphasis on relatively simple solutions
 - Absolute standards (PMF and MCE)
 - Lack of national perspective

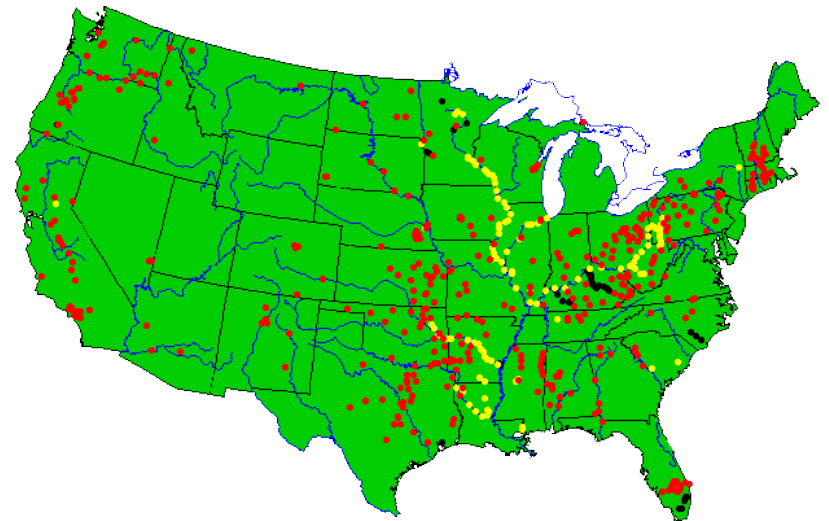
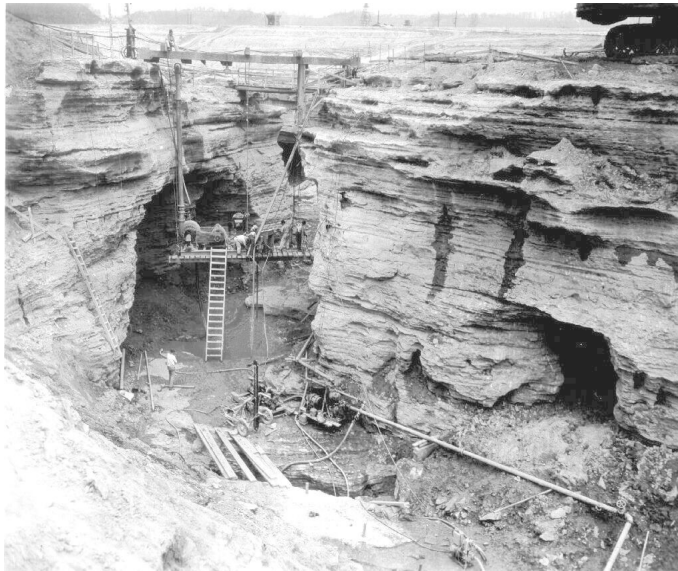




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Risk Management

- Which dams need to be modified?
- What modifications are required?
- In what order should they be modified?





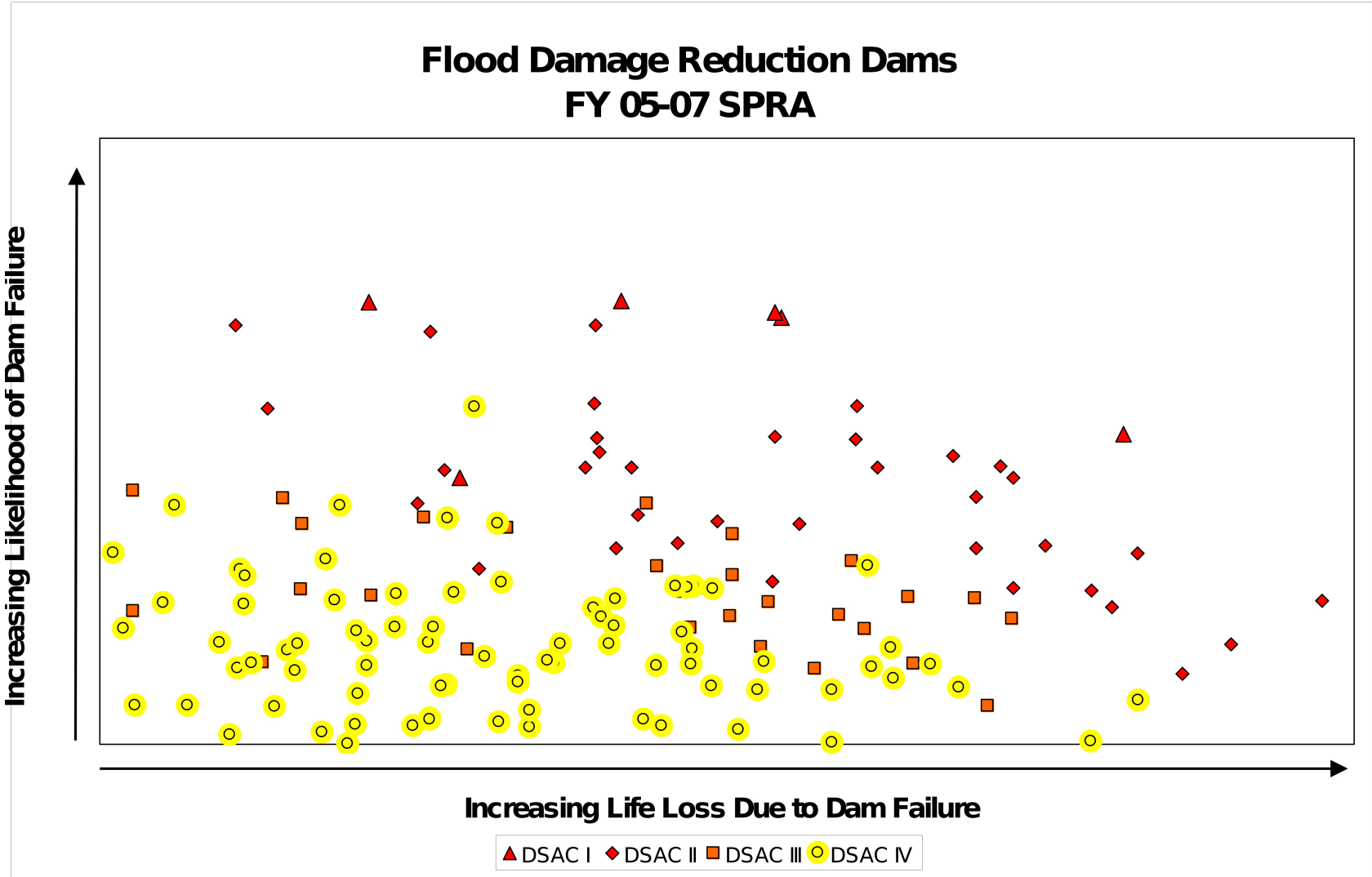
Risk Informed Standards

Dam Safety Action Class		Characteristics of this class	Actions for dams in this class
I URGENT AND COMPELLING (Unsafe)		CRITICALLY NEAR FAILURE OR EXTREMELY HIGH RISK	Take immediate action. Validate classification. Implement interim risk reduction measures Conduct heightened monitoring and evaluation. Expedite investigations. Initiate intensive management.
II URGENT (Unsafe or Potentially Unsafe)		FAILURE INITIATION FORESEEN OR VERY HIGH RISK	Implement interim risk reduction measures Conduct heightened monitoring and evaluation. Expedite confirmation of classification. High priority for investigations.
III HIGH PRIORITY (Conditionally Unsafe)		SIGNIFICANTLY INADEQUATE OR MODERATE TO HIGH RISK	Implement interim risk reduction measures Conduct heightened monitoring and evaluation. Prioritize investigations.
IV PRIORITY (Marginally Safe)		INADEQUATE WITH LOW RISK	Conduct elevated monitoring and evaluation. Give normal priority to investigations
V NORMAL (Adequately Safe)		ADEQUATELY SAFE AND RESIDUAL RISK IS CONSIDERED TOLERABLE	Conduct routine dam safety activities. Perform normal operation and maintenance.

Abbreviated version based on EC 1110-2-6064, Interim Risk Reduction Measures for Dam Safety, 31 May 2007



National Perspective





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Dam Safety Defined (Part 3)

“It also includes all actions taken to identify or predict deficiencies and consequences related to failure,”

Federal Guidelines for Dam Safety, Glossary of
Terms (FEMA 148), April 2004



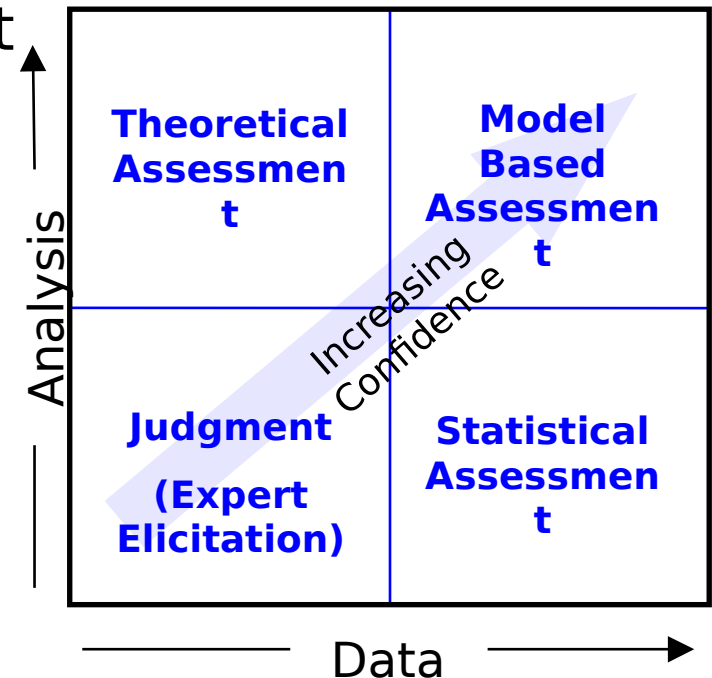
Traditional Deficiency Assessment

- Focus on engineering aspects
 - Identification based on design criteria checks
 - Prediction based on analytical models
- Insufficient consequence based criteria
 - Base Safety Condition – Rarely (if ever) less than PMF for high hazard dams



Risk Assessment

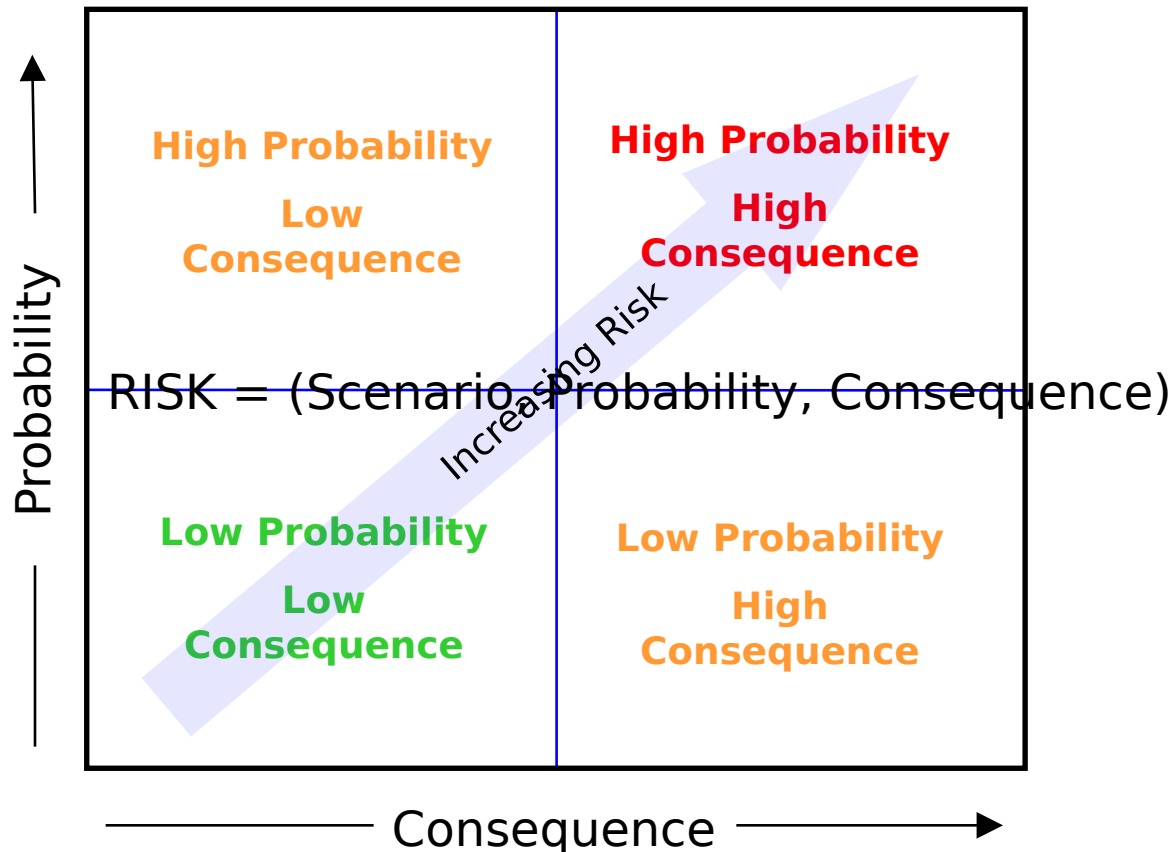
- Potential Failure Mode Analysis (PFMA)
 - Identify all characteristics, conditions, and scenarios that could lead to failure along with the potential consequences
- Risk estimation based on best available data and methods
 - Supports objective and subjective evaluations
 - Supports scalable level of effort





Risk Assessment

- Likelihood of a scenario occurring **and** the associated consequences





Dam Safety Defined (Part 4)

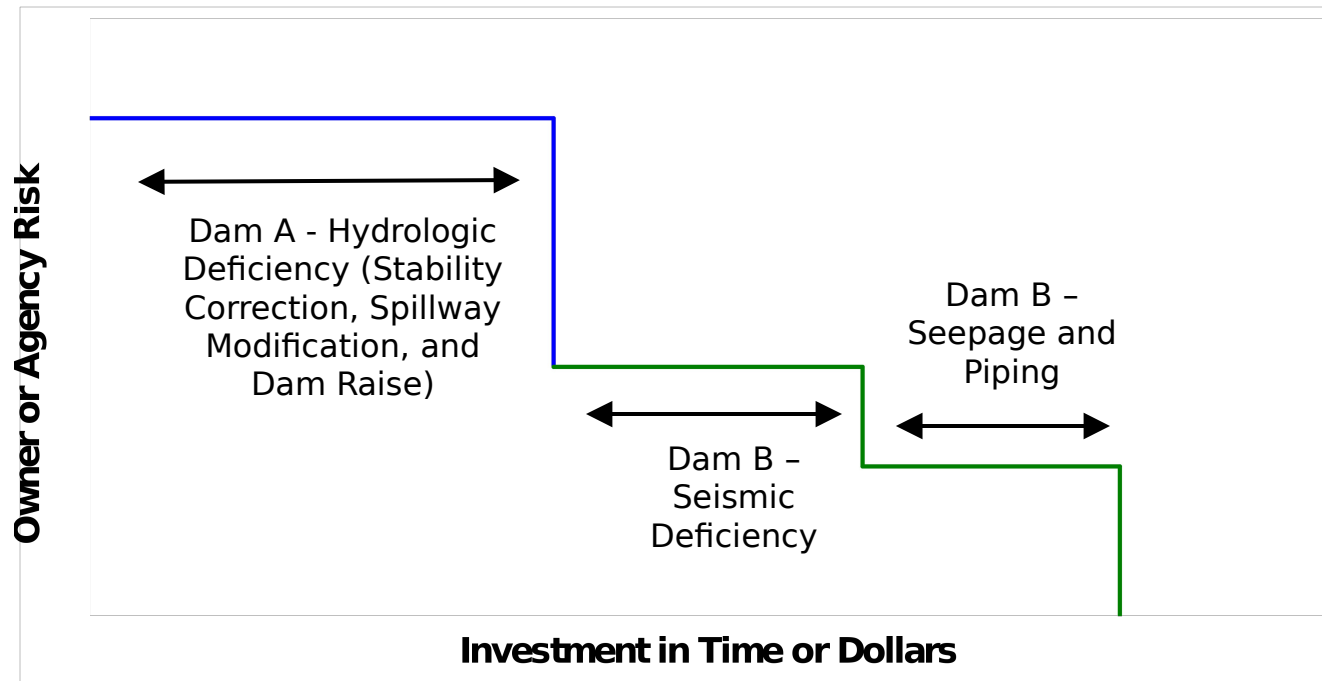
“and to document, publicize, and reduce, eliminate, or remediate to the extent reasonably possible, any unacceptable risks”

Federal Guidelines for Dam Safety, Glossary of
Terms (FEMA 148), April 2004



Traditional Deficiency Remediation

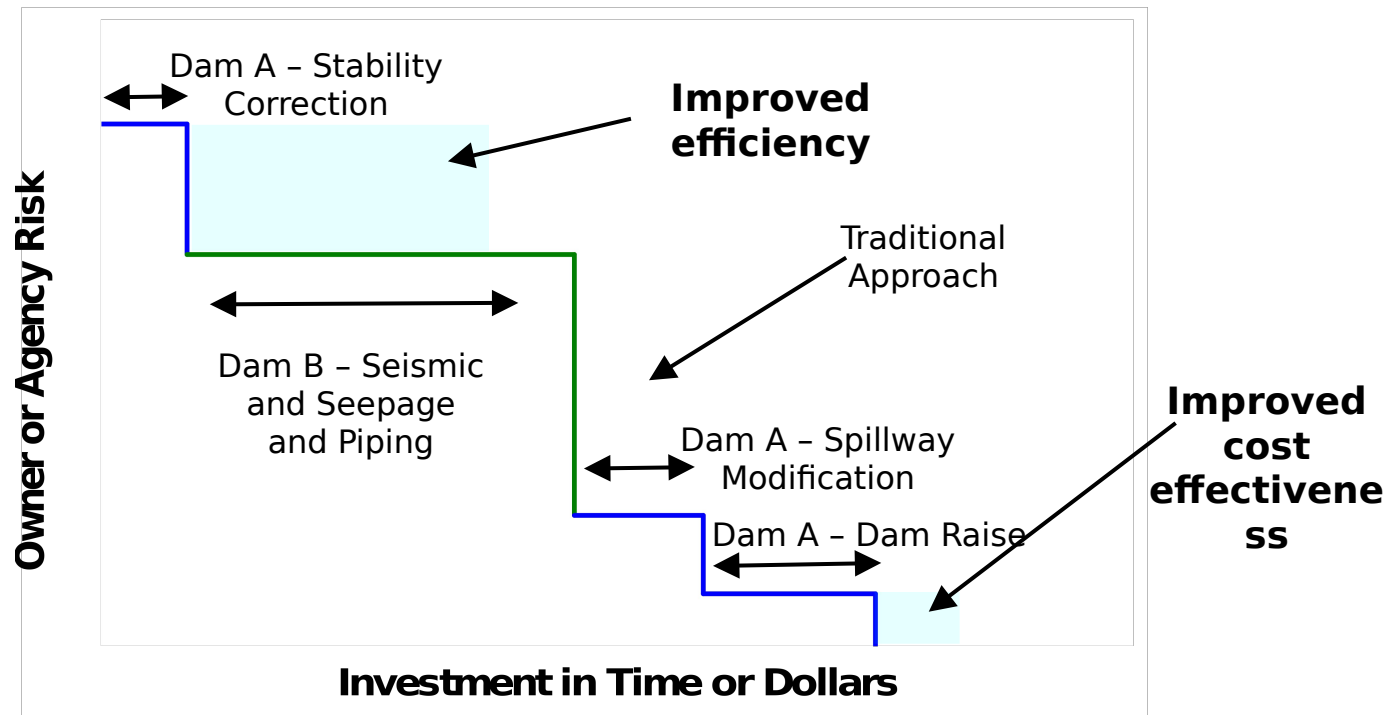
- Emphasis on a permanent and complete fix for targeted deficiency
- Lack of holistic approach for all failure modes





Risk Informed Remediation

- Pareto principle (80/20 rule)
 - Interim risk reduction
 - Staged fixes





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USACE Dam Safety Principles

- Centrally lead and de-centrally executed
- Risk informed (not risk based)
- Decision driven
- Maximize cost effectiveness
- Minimize impacts (social and environmental)
- Effective communication
- Maintain public trust